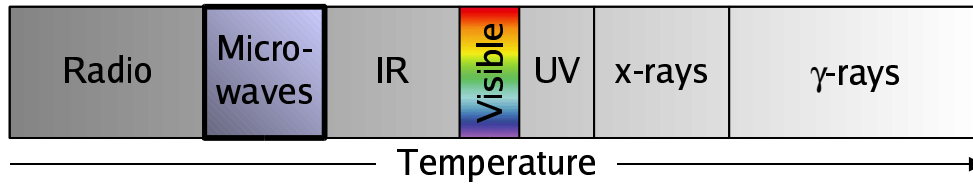


# The Cosmic Microwave Background Radiation

PhD student Erik Elfgren, Sweden



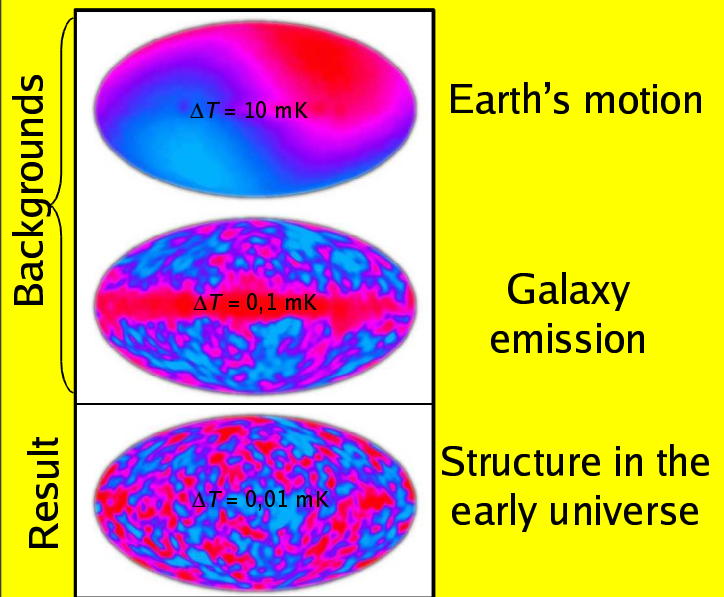
## Properties

- Omnipresent radiation
- Emitted when the universe was about 300 000 years old
- Almost isotropic
- Temperature  $T = 2,725$  K
- $\Delta T$  variations in  $T$  are the seeds for galaxies, stars etc

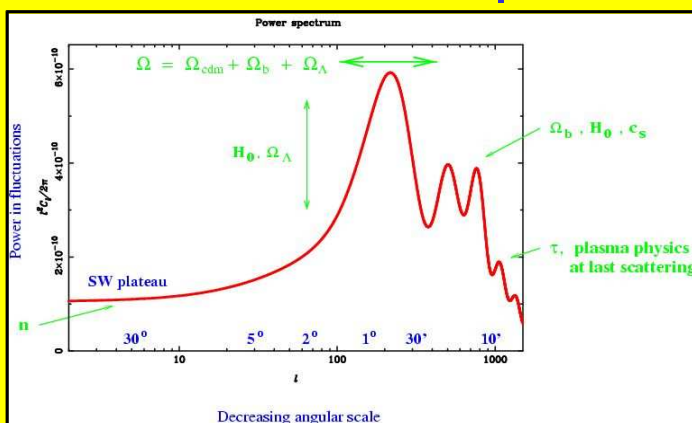


Structure scale

## $\Delta T$ from different sources



## The power spectrum



### Answers the questions:

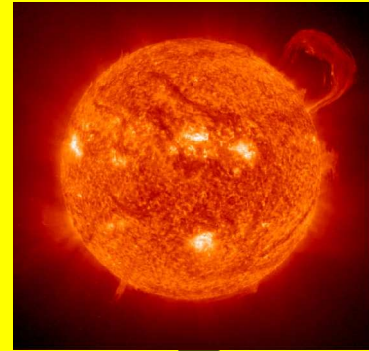
- Expansion rate of the universe?
- Accelerating universe?
- Dark matter?
- Cosmological constant?
- Inflation?
- Superstring theory?

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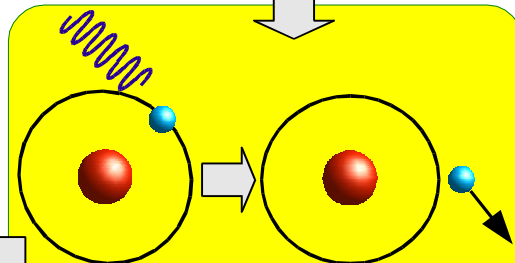
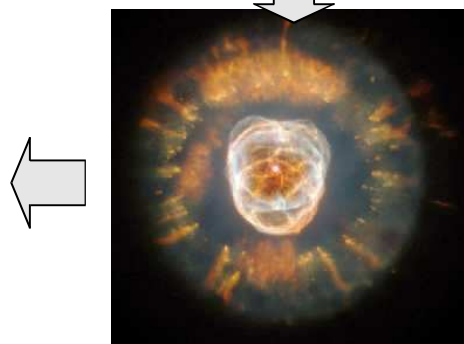
## Population III stars

- Heavy:  $M \sim 100 M_{\text{sun}}$
- Metal poor:  $Z \sim 10^{-5}$
- Short lived:  $\sim 1$  million years
- Hot:  $T \sim 100\,000$  K
- Finish as supernovae



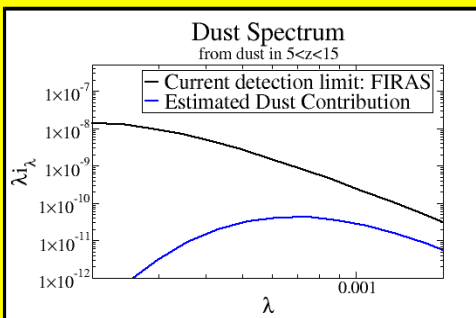
## Dust

- Produced by PopIII stars
- Heated by PopIII stars
- Emits IR light at  $T_d > T_{\text{CMB}}$
- Different spectrum than the CMB
- Consists of e.g. N, O, Si



## Reionization

- Occurs between  $z \sim 5-15$
- The photons heat the dust



## Results

- No detectable dust  $5 < z < 15$
- PopIII halos might be detected with future high-precision instruments

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